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Portfolio Composition Choice: A Behavioral Approach

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This experimental study investigates portfolio composition choice for different types of financial assets and different levels of wealth. For a group of financially sophisticated executive MBA students with work experience in capital markets, the findings of this study indicate that the proportion of wealth invested in risky assets increases with wealth for all portfolio compositions examined, and increases with the degree of asset risk. This proportion is found to be as much as three times higher for common stocks than for options: For stock portfolios, it increases from 33% to 44% over the five wealth levels examined, and for options it increases from 11% to 17%. These results may imply a decreasing rel w proportions of their wealth in risky assets possess the following characteristics: they do not invest in options in real life; they sometimes buy lottery tickets; they assign a higher risk level to options than to common stocks; they are female; and they are employed.

Portfolio theory and capital asset pricing have been covered extensively in the literature, but little attention has been paid to the behavioral aspects of individual investor portfolio composition choice. Recent behavioral studies, however, inspired by researchers such as Kahneman and Tversky, have focused more on the psychological aspects of individual investment decisions.[1] Topics investigated in this literature include subjective discount rates, overconfidence, overreaction and underreaction, loss aversion and narrow framing, mental accounting, and investor tendency not to realize losses.

Relative risk aversion (RRA) has also been examined, and the findings, reviewed in the next section, are inconclusive. Furthermore, the impact of RRA on individual portfolio composition choice, and its variation with wealth, asset risk, and personal characteristics, has not been fully examined experimentally. This study, therefore, aims to fill this gap by focusing on how the proportion of wealth invested in risky assets (RSPR) changes with wealth and asset risk, and the extent to which this risky proportion is affected by personal characteristics.

For subjects with higher formal education, financial sophistication, and work experience in the capital markets, our findings may indicate that the degree of RRA decreases with wealth for all portfolio compositions examined. For stock (and risk-free) portfolios, the RSPR increases from 33% to 44% over the five wealth levels examined, and for options portfolios it increases from 11% to 17%. The RSPR is also found to be as much as three times higher for common stocks than for options.

Various personal characteristics examined here are found to have a statistically significant effect on the degree of RSPR exhibited. Specifically, those who invest relatively low proportions of their wealth in risky assets possess the following characteristics: They do not invest in options in real life; they sometimes buy lottery tickets; they assign a higher risk level to options than to common stocks; they are female; and they are employed.

We proceed as follows. Section 2 briefly reviews the relevant literature; section 3 discusses the research issues; section 4 describes the experimental design; section 5 presents the findings and discusses the empirical results; and section 6 provides a brief summary.

Literature Review

Following the expected utility theory of von Neumann–Morgenstern [1953], Arrow [1965] and Pratt [1964] derived two measures of risk aversion: absolute risk aversion (ARA), and relative risk aversion (RRA). Their measures of ARA and RRA are given by $-U''(W)/U'(W)$ and $W \cdot ARA$, respectively, where W denotes wealth and U(W) is the von Neumann–Morgenstern utility function defined over an individual's wealth, which is assumed to be increasing and differentiable. It is commonly assumed that $U'(W)$ is positive (implying that more wealth is desirable), and that $U''(W)$ is negative for risk-averse individuals. The size of the RRA measures the degree of individual risk aversion with respect to wealth (a higher RRA implies higher risk aversion). The RRA can be decreasing, constant, or increasing. A decreasing RRA indicates that as individual wealth increases, the proportion of wealth in-

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vested in risky assets will increase. Thus, the RRA indicates the proportion of risky assets in the portfolio.

Risk perception in psychology and economics is discussed by Arrow [1982]. But empirical studies of Arrow–Pratt risk aversion measures are not completely conclusive about whether RRA decreases, stays constant, or increases with wealth. Friend and Blume [1975] find that RRA patterns vary with the definition of wealth. Cohn et al. [1975] find strong evidence of decreasing relative risk aversion: As wealth increases, a higher proportion of total wealth is committed to risky assets. They stress, however, that their conclusions must be advanced cautiously, mainly because their sample was drawn from household asset portfolios.

According to Graves [1979], in a portfolio situation where the degree of RRA is important, one should prefer the hypothesis of decreasing RRA over relevant ranges of wealth. Siegel and Hoban [1982] find decreasing RRA when wealth is defined as net worth excluding housing and the population is restricted to the wealthier half of households. Morin and Suarez [1983] present an empirical investigation of the demand for risky assets of individual Canadian households using data from the Survey of Consumer Finances. Their results generally point to decreasing RRA when housing ownership is either excluded from the definition of wealth or treated as a riskless asset.

Szpiro [1986] examines the hypothesis of constant relative risk aversion (CRRA) for fifteen countries, using property/liability insurance data. He shows that CRRA cannot be rejected for more than half the cases. He also estimates the degree of RRA, and finds that it usually lies between 1 and 2. In an experimental investment study, Levy [1994] finds that decreasing ARA is strongly supported, but increasing RRA is rejected. Dalal and Arshanapalli [1993] also show in their empirical study that constant RRA is very plausible.

Isaac and James [2000] find that their estimates of the constant RRA utility function parameter are not stable within individuals across different institutions. Donkers, Melenberg, and Van Soest [2001] question the assumption (often made in economic studies) that attitudes toward risk do not vary across individuals. Based on questions about lotteries in a household survey, they find significant relationships between risk aversion and age, gender, education level, and income. Using a stochastic dominance methodology, Levy and Levy [2001] find in their experimental study that most individuals are not risk-averse.[2]

This study aims to extend prior studies of decision-making under uncertainty. Its purpose is threefold: 1) to examine asset substitution for different "risk/return" asset types across various wealth levels; 2) to investigate how the RRA changes with wealth for different portfolio compositions; and 3) to test the impact of personal characteristics on the proportion of wealth invested in risky assets for different portfolio compositions. We use a much wider spectrum of personal characteristics, such as sex, marital status, home ownership, and employment, than prior experimental studies. Also, our sample is characterized by both increased formal education in economics and finance, and actual investment experience in bonds, stocks, and more complex derivative instruments such as options and futures. The underlying aim of this sample selection is to examine portfolio composition choices and behavior of RRA for knowledgeable and financially experienced individuals.

The Research Issues

According to portfolio theory and observed investor behavior, the risky proportion (RSPR) decreases with the risk level of the asset, and increases with the number of types of risky assets in the portfolio.[3] Also, the proportion of individuals investing some positive portion of their wealth in risky assets decreases with the risk level of the assets and increases with the wealth of the individuals. In addition to testing for the form and magnitude of the RSPR, this study also examines the *magnitude* of the change in the RSPR with respect to the risk level of the assets, and the *extent* to which the proportion of individuals undertaking risk changes with wealth and asset risk.

Portfolio theory also implies that given two portfolios, each consisting of one risk-free and one risky asset, the ratio of the risky proportions in the two portfolios, P_i/P_j, will reflect the different risk level of asset i compared to j. Furthermore, since the relative risk ratio for the two risky assets is constant, the resulting risky proportion ratio, P_i/P_j, will be constant over wealth levels. The extent to which this risky proportion changes with wealth will also be tested.

The utility function for risk-averse individuals increases at a decreasing rate with wealth. That is, $U'(W) > 0$ and $U''(W) < 0$, such as in the case of the following two utility functions: $U(W) = LnW$ and $U(W) = W^{1/2}$. Such utility functions, as demonstrated by Arrow and Pratt, exhibit CRRA, which implies that an individual's RSPR will not vary with his wealth.

CRRA is also consistent with decreasing *absolute* risk aversion, which implies that the absolute dollar amount of wealth invested in risky assets increases with wealth level. We want to investigate how, if at all, the RSPR changes with wealth, and how its variation with wealth depends on the risk level of the asset.

According to utility theory, the distinct traits and behavior patterns of individuals are reflected by distinct utility functions, which imply differing investment strategies and degrees and patterns of risk aversion. This variety is also reflected by various RSPR measures, or, equivalently, various portfolio composi-

tion choices. In line with Levy and Levy's [2001] claim of the importance of heterogeneous expectations, this study investigates the relationship between personal characteristics and the RSPR.

We gathered information on five personal characteristics, OPT, LTRY, RSKR, SEX, and EMPL.[4] They are defined and described later in Table 5, and we briefly discuss their expected impact below.

OPT is a dummy variable with a value of 1 for subjects who invest in risky assets like options in real life. We therefore expect these subjects to have a higher RSPR, or, in other words, that OPT will have a positive impact on RSPR. In contrast, we cannot a priori determine the impact of buying lottery tickets (LTRY) on the RSPR. Subjects who are aware of the higher riskiness of options compared with common stock (i.e., those have higher RSKR values) will likely have lower RSPR values than those who are not.

While the impact of the SEX variable cannot a priori be determined either, employment (EMPL) is assumed to represent some sort of stability, or at least the existence of a high opportunity cost for making wrong investment decisions in the face of uncertainty and risk. We therefore expect the sign of EMPL to be negative (a value of 1 designates being employed).

To empirically examine the impact of the five characteristics on the RSPR, the following regression equation is estimated:

$$\text{RSPR} = \alpha + \beta_1 \text{OPT}_i + \beta_2 \text{LTRY}_i + \beta_3 \text{RSKR}_i + \beta_4 \text{SEX}_i + \beta_5 \text{EMPL}_i + e_i \quad (1)$$

where i = 1, 2, … , n subjects, and RSPR is the proportion of wealth invested in risky assets. Based on the preceding discussion, we expect the OLS coefficients to carry the following signs: $\beta_1 > 0$; $\beta_2 \gtreqless 0$; $\beta_3 < 0$; $\beta_4 \gtreqless 0$; and $\beta_5 < 0$.

Methodology

The questionnaire consisted of two parts: The first contained two general questions, and the second contained personal questions about the individual's actual investment activities, attitude toward risk, and particulars like age, sex, and employment (see the Appendix). The subjects were first presented with a brief introduction to the experiment. The first question was:

> **Question 1:** Suppose your investment horizon is one year (i.e., investing at the beginning of the year and liquidating the investment at the end of the year), and that you plan to invest a certain dollar amount in two distinct types of investment assets: 1) risk-free assets (such as savings accounts, Treasury bills, and money market funds), and 2) common stocks. Below you are given a matrix containing these two distinct types of assets as well as the following five hypothetical levels of investment: $10,000, $50,000, $100,000, $500,000, and $1 million. For each investment level, state the *dollar amount* you will invest in each of the two distinct types of assets (risk-free and common stocks), and please make sure the two dollar amounts you state add up to the *total* dollar amount given below.

Question 2 was similar to Question 1, except that the category "common stocks" is replaced by "call options."

The second part of the questionnaire attempted to gather information about the characteristics, and the subjects were also asked their opinion about the risk of stocks and options. More specifically, they were requested to assign a number (below, above, or equal to 1) to represent the risk of options relative to stocks, which are assumed to have a risk level of 1. Subjects were also asked whether they invest in real life in savings plans, stocks, or options, and whether they buy lottery tickets. These questions test the direction and magnitude of the effect of personal characteristics on the degree of risk aversion.

The questionnaire was distributed to 245 executive MBA students at New York University, who had the option to complete only the first part or both parts of the questionnaire. The rationale was to determine how the portfolio composition choices differed between those who completed both parts and those who only completed the first part.

223 subjects completed the first part, and 133 also completed the second part. For comparative purposes, the questionnaire was also distributed to 203 economics students at Haifa University in Israel, and 190 of them completed the entire questionnaire.

The advantages and disadvantages of experimental studies noted in the literature also apply to this study. Nonetheless, the questions were examined carefully, resulting in no notable difference in response pattern. Furthermore, as noted later, we found no evidence of sample segmentation. The questionnaires were distributed during class, and the students were given sufficient response time and informed of the importance of the topic. Therefore, we believe the students were positively motivated to complete the questionnaire carefully and diligently, even without monetary incentives, which psychologists claim do not necessarily improve performance anyway.

Gneezy and Rustichini's [2000] findings are consistent with this claim. Loewenstein [1999] also argues that experimental economists should not deceive themselves into believing that such rewards allow them to control the incentives operating in their ex-

periments. And our analysis, too, implies that reliable responses appear to have been part of the subjects' utility functions. This contention seems consistent with Warneryd's [1996] conclusion that questions involving hypothetical risky choices can be used in survey contexts.

Results

Given that our findings (reported later) imply a very high similarity between the two U.S. samples and the Israeli sample, the main body of the results analysis will be based on the first U.S. sample. The results for the second U.S. sample and the Israeli sample are presented in Table 7 and discussed later in this section.

The Pattern of the Risky Proportion (RSPR)

Descriptive statistics of subject responses for the first part of the questionnaire are summarized in Table 1, which gives investment proportions in risk-free assets versus risky assets for two types of portfolio composition (hereafter denoted C), and five different levels of wealth ranging from $10,000 to $1 million. The portfolio compositions consist of risk-free assets and one of the following types of risky assets corresponding to the two panels in Table 1: stocks or options. We refer first to the *mean* value of the portfolio choice compositions across the five wealth levels, represented by the right-hand column in Table 1. The risky proportion, as shown in Table 1, is a negative function of the risk level of the particular asset. That is, the riskier the asset, the lower the proportion of total wealth invested in it.

When stocks represent the risky component (C1), the mean value of the RSPR across the five wealth levels is 39%; the remaining 61% is invested in risk-free assets. This risky proportion decreases sharply to 16% for options (C2), and the difference between the two RSPR values is statistically significant.[5] The results for C1 and C2 also support the contention that, given two portfolios, C_i and C_j, each of which contains one risk-free asset and one risky asset, the risky proportion ratio, P_i/P_j, will reflect the relative risk differential of the two risky assets, and should therefore be constant over different wealth levels.

The risky proportion ratio between C1 and C2 (stocks versus options) is about 2.5, and is fairly constant across the five wealth levels. These findings are attributed to Kahneman and Tversky's [1992] "loss aversion" concept, which states that investors attach higher weight to losses than to gains. With the wealth level held constant, losses clearly increase with the riskiness of the asset. The higher RSPR found for stocks may be attributed not only to the higher risk level of options, but also to the "familiarity" or "home bias" factor examined in different contexts in Huberman [2001], Coval and Moskowitz [1999], and Grinblatt and Keloharju [2001].

To investigate the variation in the proportion of *individuals* investing in risky assets, the percentage proportion of *all subjects* investing in a specific asset was computed for various wealth levels and portfolio compositions. The results appear in Table 2. For a wealth level of W = $10,000, the proportion of all subjects (hereafter called the "subject proportion") decreases significantly from 73% for stocks (C1), to 48% for options (C2). The results in Table 2 also show that, for the two portfolio compositions, the proportion of subjects investing some portion of their wealth in risky assets increases with wealth level. In fact it reaches almost 100% for a wealth level of $1 million and moderately risky assets (stocks in C1). But for the riskier asset [options (C2)], even at the relatively high wealth level of W = $1 million, 14% of all individuals will invest *nothing*.

A related issue is the consistency of the RSPR variation across subjects and across types of risky assets for

Table 1. *The Investment Proportions in Risk-Free Assets Versus Risky Assets for Two Types of Portfolio Composition and Different Levels of Wealth (%)*

	Wealth ($000)					
Asset Type	**10**	**50**	**100**	**500**	**1,000**	**Mean**
			Composition 1			
Risk-free	67	62	60	58	56	61
	(0.45)	(0.39)	(0.38)	(0.42)	(0.44)	(0.42)
Stocks	33	38	40	42	44	39
	(0.92)	(0.63)	(0.57)	(0.59)	(0.57)	(0.65)
			Composition 2			
Risk-free	88	85	84	84	82	84
	(.23)	(.24)	(.23)	(.22)	(.24)	(.23)
Options	12	15	16	16	18	16
	(1.62)	(1.35)	(1.15)	(1.14)	(1.11)	(1.25)

Note: Number in parentheses is the coefficient of variation (COV) defined as the standard deviation (σ) over the mean (μ).

Table 2. *The Percentage Proportion of All Subjects Investing in Specific Assets for Various Wealth Levels and Portfolio Compositions*

	Wealth ($000)				
Asset Type	**10**	**50**	**100**	**500**	**1,000**
			Composition 1		
Risk-free	93	98	99	99	99
Stocks	73	93	95	97	98
			Composition 2		
Risk-free	98	98	100	100	100
Options	48	67	79	86	86

various wealth levels. We estimate the following regression equation for different wealth levels and different types of risky assets:

$$P_i = \alpha_{ij} + \beta_{ij} P_j + e_{ij} \quad (2)$$

where i and j denote portfolio compositions C1 and C2 for stocks and options, respectively, and P denotes the RSPR. This regression equation was estimated for each of the five wealth levels. The number of observations in each regression is 133, equal to the number of subjects.

Table 3 presents the results for the two extreme wealth levels, W = $10,000 and W = $1 million. The results imply a high degree of consistency within subjects. For the W = $10,000 level, R^2 is 0.333; for W = $1 million, R^2 is 0.199. Both are significant at 1%.

We now focus on the pattern of the risky proportion (RSPR) with respect to variations in wealth and portfolio composition. The descriptive statistics of this pattern appear in Table 1. The results clearly indicate that, as wealth increases, the absolute dollar amount invested in risky assets increases. This holds true for all types of portfolio composition and for all examined wealth levels, and it appears consistent with decreasing absolute risk aversion (ARA).

The results in Table 1 demonstrate that the RSPR increases with wealth. The values of the RSPR for the two extreme wealth levels (W = $10,000 and W = $1 million) are 33% and 44%, respectively, for the first portfolio composition (C1) of risk-free assets and stocks, and 12% and 18% for C2 (options). All these differences are significant at the 5% level. These results seem consistent with decreasing RRA as well.

Furthermore, among relatively low levels of wealth (W = $10,000 to W = $100,000), the RSPR increases sharply with wealth. Among relatively high levels of wealth (W = $100,000 to W = $1 million), the RSPR increases only moderately. This result also holds true for C1 and C2. Like the *mean* proportion of wealth invested in risky assets, the coefficient of variation (COV), the standard deviation over the mean, also declines with wealth. As indicated in Table 1, the decline is sharp for lower wealth levels (W = $10,000 to W = $100,000), and moderate for higher ones (W = $500,000 and W = $1 million). This result also holds across C1 and C2.

The level of COV, as demonstrated in Table 1, also increases with the degree of asset risk. These results imply that 1) not only does the RSPR increase with wealth, but its variability decreases, and 2) the RSPR decreases with the degree of asset risk, while its variability increases.

A linear regression test for increasing RSPR is represented by the following regression equation:

$$D_{ij} = \alpha_i + \beta_i P_{ij} + e_{ij}; i = 2.....5 \text{ wealth levels}, \quad j = 1.....133 \text{ subjects} \quad (3)$$

where:

- P = RSPR = the proportion of wealth invested in risky asset
- D = the incremental proportion of wealth invested in risky assets.
- W_i = the wealth at level i.
- Y_i = the dollar amount invested in risky assets at wealth level i.
- $D_i = (Y_i - Y_{i-1})/(W_i - W_{i-1})$; i = 2. … 5 wealth levels.
- e_{ij} = the error term.

Table 3. *Statistical Results of the Regression Between the Proportion (P) Invested in Stocks and Options for Two Wealth Levels: $10,000 and $1 Million*

	$10,000	**$1 Million**
α	0.222	0.339
β	0.883	0.566
R^2	0.333	0.199

Note: The two regressions are as in Equation (2): $P_i = \alpha_{ij} + \beta_{ij} P_j + e_{ij}$, where *i* and *j* denote portfolio compositions C1 and C2, for stocks and options, respectively, and *P* is the proportion invested in the risky asset. The number of observations in each of the two regressions is 133, which is the number of subjects. All values of α, β, and R^2 are significant at 1%.

Table 4. *Statistical Results of the Regression Between the Incremental Proportion (D) and the Proportion of Wealth Invested in Risky Assets (P), for Portfolio Composition of Risk-Free Assets and Stocks (C1) at Different Wealth Levels*

W($)	α	t_α	β	t_β	R^2
50,000	0.011	1.34	1.05	57.4	0.96
100,000	–0.013	–0.65	1.08	24.2	0.82
500,000	–0.015	–3.16	1.05	106.8	0.99
1 million	–0.016	–0.96	1.08	31.9	0.89

Note: The estimated regression is Equation (3): $D_{ij} = \alpha_i + \beta_i P_{ij} + e_{ij}$, i = 2 … 5 wealth levels, j = 1 … 133 subjects. All the values of β and R^2 are significant at 1%.

An increasing RSPR is implied by a β value greater than unity. Equation (3) was estimated ten times corresponding to C1 and C2 and four wealth changes. Results across the ten regressions are very similar, so only the results for C1 appear in Table 4. For the four regressions corresponding to the four wealth changes reported in Table 4, the value of β ranges between 1.05 and 1.08, the value of R^2 is between 0.82 and 0.99, and both β and R^2 are significant at 1%. As noted above, very similar results were obtained for the second portfolio composition (C2). These results demonstrate that an overall increasing RSPR characterizes the portfolio composition choices of the subjects in the experiment.

The Impact of Personal Characteristics on the Risky Proportion (RSPR)

We now turn to the impact of personal characteristics on the RSPR for the two portfolio compositions (see Table 5). The distribution of these characteristics is summarized as follows: 28% invest in options; 62% sometimes buy lottery tickets; 90% think that options are riskier than stocks; 63% are male; and 81% are employed.

Equation (1) was estimated for portfolio compositions C1 and C2. The statistical results appear in Table 6, and can be summarized as follows:

- The R^2 values for the two portfolios are statistically significant at 5%, which implies that the five personal characteristics are statistically related to the subjective proportion of wealth invested in risky assets across individual investors.
- The impact of OPT is positive, as expected, and stronger for portfolio C1. However, when confined to investment in options *alone* (C2), the differential impact is clearly lower.
- Subjects who sometimes buy lottery tickets have lower RSPR values than those who do not, perhaps partially due to the substitution effect of this type of risky asset.
- The results concerning the "risk" variable (RSKR) indicate that subjects who are aware that options are riskier than stocks have lower RSPR values than those who are not. The effect of the RSKR variable is negative and significant at 1%.
- Male subjects tend to have higher RSPR values than females for stocks (C1) and for options (C2). This prediction appears consistent with Barber and Odean [2001], who find that men are overconfident and trade more excessively than women.
- The employment variable (EMPL) has a negative impact on the RSPR, perhaps due to the "stability" and/or "opportunity cost" arguments offered in the preceding section.

Overall, these results imply that personal characteristics are related to the RSPR. Individual subjects invest different proportions of wealth in risky assets due to different personal characteristics. At least part of the effect of these characteristics can be explained by the link between emotions and economics discussed by Elster [1998] and Loewenstein [2000], and the relationship between psychology and economics surveyed by Rabin [1998].

Specifically, the lower level of RSPR found for low wealth levels may be explained by the "loss aversion" (rather than risk aversion) concept incorporated in Kahneman and Tversky's [1979] prospect theory, and recently advanced by many researchers, including Rabin and Thaler [2001]. They note that loss aversion is the tendency to feel the pain of a loss more acutely than the pleasure of an equal gain. Loss aversion can be related to visceral factors (Loewenstein [2000]), which refers to a wide range of negative emotions. To predict or make sense of viscerally driven behavior,

Table 5. *Personal Characteristics*

Variable Number	Variable Name	Variable Symbol	Variable Values		Proportion of Value "1" (%)[a]	Expected Impact[b]
			0	1		
1	Buying call options	OPT	no	yes	28	+
2	Buying lottery tickets	LTRY	no	yes	62	?
3	Option risk/stock risk	RSKR	less than unity	greater than unity	90	–
4	Sex	SEX	female	male	63	?
5	Employment	EMPL	no	yes	81	

[a]This is the percentage proportion of all 133 subjects whose response was designated by the value "1" of the dummy variable.
[b]"+" and "–" designate positive and negative impact, respectively.

Table 6. *The Impact of Personal Characteristics on the Proportion of Wealth Invested in Risky Assets for Two Types of Portfolio Compositions*

	C1 (Stocks)		C2 (Options)	
	β	t_β	β	t_β
Intercept	0.517	12.27	0.368	11.41
1. OPT	0.106	5.00	0.004	0.27*
2. LTRY	–0.058	–2.96	–0.027	–1.79
3. RSKR	–0.100	–3.22	–0.186	–7.80
4. SEX	0.076	3.79	0.019	1.21*
5. EMPL	–0.096	–3.81	–0.053	–2.77
R^2—Adjusted	0.11	15.80	0.09	13.54

Note: The estimated regression is given by Equation (1). In each regression, the dependent variable is the proportion of wealth invested in risky assets (RSPR), which is computed from the subjects' responses concerning their portfolio composition choices for each portfolio composition. The definitions of the variables is as follows: 1) OPT = buying call options (0 = no; 1 = yes); 2) LTRY = buying lottery tickets (0 = no; 1= yes); 3) RSKR = the ratio of option risk/stock risk (0 = less than unity; 1 = greater than unity); 4) sex (0 = female; 1 = male); 5) EMPL = employment (0 = no; 1 = yes).

- For all regressions, the first column represents the values of the OLS coefficients, and the second column gives their t-statistic. In the last line, it is R^2 and F-statistics, respectively.
- For more on the variables, see Table 5.
- In all regressions, R^2 is significant at 5%; the asterisk (*) denotes no significance at 5%.

Loewenstein concludes, it is necessary to incorporate visceral factors into a model of economic behavior. The incorporation of personal characteristics in this study is a step in this direction.

Intersample Comparison

We now briefly compare the major findings from the first sample to those of the second ninety-subject sample (which did not answer the personal characteristics questions). We aim to determine whether the second sample makes different portfolio composition choices regarding risky assets.6 We then compare the U.S. executive MBA sample to the Israeli economic student sample to test the extent to which changes in RSPR patterns are similar in a (narrow) international perspective.

The major findings for the three samples are summarized in Table 7, which exhibits the RSPR for the five wealth levels and the two portfolio compositions. The first line in each of the compositions represents the findings for the first U.S. sample, which already appeared in Table 1. The second and third lines are for the second U.S. sample and the Israeli sample, respectively.

A comparison of the first two lines in each of the compositions in Table 7 clearly demonstrates that the findings for the two U.S. samples are nearly identical. This implies that the tendency to respond to personal characteristics questions in this study does not have an impact on the pattern of the RSPR.

Although the findings for the Israeli sample are similar to those of the U.S. sample, there are some interesting differences worth noting. The results for the "mean" column in Table 7 imply that the Israeli subjects possess a higher degree of risk aversion than their U.S. counterparts. For the stock portfolios (C1) the Israelis' RSPR is much lower than in the U.S.

Table 7. *Proportion of Investment in Risky Assets for Two Types of Portfolio Composition and Different Levels of Wealth for Three Samples (%)*

		Wealth ($000)					
Composition	**Asset Type**	**10**	**50**	**100**	**500**	**1,000**	**Mean**
		32	36	39	41	43	38
1	Stocks	33	38	40	42	44	39
		31	38	41	43	45	39
		30	29	30	30	31	30
2	Options	12	15	16	16	18	16
		14	15	17	18	19	17
		19	18	18	18	20	19

Note: This table corresponds to Table 1, except that the risk-free proportion and the coefficient of variation are not given. Table 1 is for the 133-subject sample who elected to answer the personal characteristics questions, while this table presents the results for the additional two samples: the ninety-subject sample that did not respond to the personal questions, and the 190-subject Israeli sample. Accordingly, the first, second, and third line for each of the two asset type compositions in this table present the results for these three samples, respectively.

sample. For the option portfolios (C2), the Israelis' RSPR is a bit higher for lower wealth levels, but similar for high wealth levels. It appears that the Israeli economics students may be less aware of the risk level of derivative securities than the U.S. executive MBA students. The proportion of subjects actually buying options in real life is 28% in the U.S. sample, compared to only 14% in the Israeli sample. In contrast, the proportion of subjects buying lottery tickets is lower in the U.S. sample (62%) than in the Israeli sample (71%).

Another important difference is that the U.S. sample seems to show a decreasing RRA, but the Israeli sample seems to have a roughly constant RRA for the two portfolio compositions in this experiment. This finding may also be consistent with the Israeli sample's likely higher degree of RRA noted above.

As noted previously, the U.S. sample consisted of executive MBA students, while the Israeli sample consisted of full-time economics students. The personal characteristics questions were designed to reflect this difference: We replaced the employment question with an age question on the Israeli sample's questionnaire. Also, the RSKR variable question in the U.S. study was replaced with a simpler one in the Israeli study, asking the subjects whether they think options are riskier than stocks (without attaching a specific numerical value).

The regression results of the relationship between the RSPR and the five personal characteristics for the Israeli sample are given by Equation (4) (for the "stocks" case).

$$\underset{}{\text{RSPR}} = \underset{(7.18)}{0.57} + \underset{(6.50)}{0.13\ \text{OPT}} + \underset{(1.12)}{0.02\ \text{LTRY}} + \underset{(0.66)}{0.02\ \text{RSKR}} + \underset{(2.75)}{0.04\ \text{SEX}} - \underset{(-3.98)}{0.01\ \text{AGE}} \qquad (4)$$

These findings are similar to those for the U.S. sample. The relationship between the risky proportion and the personal characteristics is statistically significant, although lower than for the U.S. sample ($R^2 = 0.07$; $F = 10.26$; significance level = 1%). The variables generally carry the expected sign and most are statistically significant.

Summary

This experimental study investigates the portfolio composition choices of individual subjects for different wealth levels and different types of risky financial assets. The study examines the pattern of the proportion of wealth invested in risky assets (RSPR) across varying levels of wealth, types of financial assets, and portfolio compositions for a highly knowledgeable and experienced group of individual subjects.

A questionnaire was presented to subject samples of executive MBAs in the U.S. and economics students in Israel to gather information on two interrelated issues: 1) the pattern of the risky proportion (RSPR) across wealth levels and portfolio compositions; and 2) the impact of personal characteristics on the RSPR.

The findings reconfirm actual investment behavior that implies a negative relationship between the risk level of the assets and the RSPR. This proportion was found to be as much as three times higher for common stocks than for options. The results also support the contention that the risk proportion ratio for two different portfolio compositions reflects the risk differential of the two risky assets, and will therefore stay constant across different wealth levels. The risky proportion ratio between stocks and options was about 2.5 for all five wealth levels. Another type of proportion examined is the "subject proportion," or the proportion of all subjects investing some positive amount in the risky component of the portfolio. The subject proportion decreased with the risk level of the asset and increased with wealth.

The findings regarding the pattern of the RSPR seem to indicate that the degree of absolute risk aversion (ARA) decreases with wealth. The degree of RRA, implied by the RSPR, also appears to generally decrease with wealth for the U.S. sample, while for the Israeli sample it is rather constant. The values of RSPR for the two extreme wealth levels (W = $10,000 and W = $1 million) for the U.S. sample are 33% and 44%, respectively, for C1 (stocks), and 12% and 18% for C2 (options). All these differences are statistically significant at 5%. A decreasing RRA may also be consistent with the high equity premium observed in the market. By this so-called "equity premium puzzle," stock returns have been historically much higher than Treasury bill returns.

Finally, the regression results indicate that personal characteristics are statistically related to the RSPR. For the two portfolio compositions (C1 and C2), R^2 is significant at 5%, and the five characteristics generally carried the correct sign and were statistically significant. Specifically, those who invest relatively low proportions of their wealth in risky assets possess the following characteristics: They do not invest in options in real life; they sometimes buy lottery tickets; they assign a higher risk level to options relative to common stocks; they are female; and they are employed.

The findings of this experimental study appear consistent with behavioral theories examined in the economic psychology literature, and may contain important implications for investment decision-making processes in the real world.

Notes

1. For a review of Tversky's contribution to behavioral economics, see Laibson and Zeckhauser [1998].
2. The issue of the RRA and portfolio composition choice investigated here is related to other behavioral economic issues, such as subjective discount rates, investor overconfidence, overreaction and underreaction, loss aversion, and mental accounting. Selected studies of these issues are given here, some of which are linked to this study later when the results are discussed. A recent and comprehensive critical review of the discount rate literature is provided by Frederick, Loewenstein, and O'Donoghue [2002].

   The subjective discount rate anomaly of decreasing rates with time and monetary sum (Thaler [1981] and Benzion, Rapoport, and Yagil [1989]) was found to be consistent with the notion of reference point (Kahneman and Tversky [1979]; Tversky and Kahneman [1986]; Loewenstein [1988]; Loewenstein and Thaler [1989]; and Thaler [1994]). More recent discount rate studies include Weitzman [2001] and Warner and Pleeter [2001].

   The overconfidence phenomenon has been examined recently in numerous studies, including Daniel, Hirshleifer, and Subrahmanyam [1998], Barber and Odean [2000, 2001], and Gervais and Odean [2001]. It is argued that overconfidence can explain high trading levels and the resulting poor performance of individual investors, and that men are more overconfident than women (Barber and Odean [2001]).

   Barberis, Shleifer, and Vishny [1998] note a large body of evidence supporting the idea that security prices underreact to news in the short run, and overreact to consistent patterns of news in the long run. Fama [1998] contends that overreaction of stock prices to information is about as common as underreaction. According to Kahneman and Tversky's [1979] loss aversion concept, people are more sensitive to losses than to gains. Barberis and Huang [2001] argue that this concept can improve our understanding of firm-level stock returns.

   A closely related concept is "myopic loss aversion," which, as defined by Thaler et al. [1997], is the combination of a greater sensitivity to losses than gains and a tendency to evaluate outcomes frequently. They, as well as Gneezy and Potters [1997], find that the more frequently returns are evaluated, the more risk-averse investors are. Experimental studies suggest that, when doing their mental accounting, people engage in "narrow framing," which is referred to as narrowly defined gains and losses. Loss aversion and narrow framing have been applied to the aggregate stock market and to retirement investment by Benartzi and Thaler [1995, 1999], and were further studied by Barberis, Huang, and Santos [2001].

   Another related phenomenon is investor reluctance to realize losses (e.g., Ferris, Haugen, and Makhija [1988] and Odean [1998]). In a recent survey of investor psychology and asset pricing, Hirshleifer [2001] sketches a framework for understanding decision biases, and discusses the importance of investor psychology for security prices.
3. This contention is consistent with both portfolio diversification, and a similar effect in the economic psychology experimental literature, which states that if a category is broken down into many subcategories more will be allocated to that category (e.g., Kahneman and Knetsch [1992]).
4. Some of these characteristics may not be purely "personal," but for expositional simplicity we refer to the whole group as "personal."
5. Mean differences discussed throughout the analysis are statistically significant unless otherwise stated.
6. As described in the previous section, two U.S. samples are used: the first 133-subject sample who answered both parts of the questionnaire (including the personal questions), and the second ninety-subject sample who answered only the first part.

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Appendix: A Questionnaire on Problems in Financial Decisions

The purpose of this experiment is to obtain some estimate of your investment preferences in various types of investment assets (instruments) for different hypothetical investment levels. The questions presented below have no unique answer. The answers may differ from one person to another according to investment preferences and financial position in the present and future. The questions you will be given are chosen from a wide spectrum of simple decision problems that can arise in different areas of one's economic behavior. This questionnaire is for research purposes only. We ask you to use your best judgment and to answer *all* questions sincerely and as best you can.

Question 1: Suppose your investment horizon is one year (i.e., investing at the beginning of the year and liquidating the investment at the end of the year), and that you plan to invest a certain amount of dollars in two distinct types of investment assets: 1) risk-free assets (such as savings accounts, Treasury bills, and money market funds), and 2) common stocks. You are given below a matrix containing these two distinct types of assets as well as the following five hypothetical levels of investment amounts: $10,000; $50,000; $100,000; $500,000; and $1 million. For each of these five investment levels, state the *dollar amount* you will invest in each of the two distinct types of assets (risk-free and common stocks), making sure that the two dollar amounts you state add up to the *total* dollar amount given below.

Risk-free assets Common stocks					
Total assets	$10,000	$50,000	$100,000	$500,000	$1 million

Question 2: This question is identical to Question 1 except that the risky asset is not common stocks but call options. For each of the five investment levels given below, state the dollar amount you will invest (buy) in the risk-free asset and the call options, making sure that the two

dollar amounts you state add up to the total dollar amount given below.

Risk-free assets Options					
Total assets	$10,000	$50,000	$100,000	$500,000	$1 million

Additional Questions

In which types of investment assets did you regularly invest in the past? (Circle your choice) Savings accounts and market instruments? yes; no; Stocks? yes; no; Options? yes; no.

Do you ever buy lottery tickes? yes; no.

If the risk level of stocks is 1, state a number (below, above, or equal to 1) to represent the risk of options *relative* to the risk of stocks. The risk of options is _____.

Age _____; Sex: M; F; Currently employed? yes; no.